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Space Administration

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MSFC-PLAN-3104

BASELINE

EFFECTIVE DATE: January 18, 2001

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

SD45

Dynamically Controlled Protein Crystal Growth (DCPCG) Investigation

Risk Management Plan

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Enclosure 5

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1. INTRODUCTION

1.1 Purpose – This plan documents the practice of Continuous Risk Management (CRM) as tailored to the Dynamically Controlled Protein Crystal Growth (DCPCG) Project. It is applied to DCPCG as a means to anticipate, mitigate and control risks and to focus project resources where they are needed to ensure success of the project. This plan is prepared in response to the requirements/guidelines of National Aeronautics and Space Administration (NASA) Policy Guideline (NPG) 7120.5A, NASA Program and Project Management Processes and Requirements, and Marshall Work Instruction (MWI) 7120.6, Program/Project Risk Management. The risk management approach for DCPCG applies to internal and external risks for DCPCG.

1.2 Assumptions, Constraints, and Policies - This plan addresses the methods and tools used in the CRM process, and addresses installing the practice on the DCPCG project. Section 5.1, Risk Management Process and Data Flow, describes the CRM process. It directs the flow of activities associated with the initial risk management practice defined in this plan. It is recognized that this plan calls for a new practice to be put into place on a project that is already in progress. It is expected that changes and improvements will be necessary over the course of time as CRM is adopted and used by DCPCG. This plan will be updated through either change pages or complete revision, depending on the magnitude of changes. This plan will be configuration controlled at its highest level by the DCPCG Level III Configuration Control Board (CCB). The risk management database (Appendices A and B) will not be controlled due to required and frequent updating.

1.3 Related Documents and Standards - The DCPCG Project Plan, MSFC-PLAN-2785, directs the activities of the overall project. The Risk Management Plan is subordinate to and an integral part of the Project Plan. NPG 7120.5A, NASA Program and Project Management Processes and Requirements, and MWI 7120.6, Program/Project Risk Management, are the controlling requirements/guidelines used in preparation of this plan.

1.4 Scope – This plan covers the entire DCPCG scope, which includes the following:

- a. Schedule – as defined in MSFC-PLAN-2785, DCPCG Project Plan
- b. Cost – as defined in MSFC-PLAN-2785, DCPCG Project Plan
- c. Science Objectives – as defined in PCG-R-0003A, DCPCG Science Requirements Document
- d. Contractual, Interface, and Safety – as defined in PCG-S-006, System Performance Specification for DCPCG Hardware/Software
- e. DCPCG Quality Plan, MSFC-PLAN-2889 and DCPCG Project Plan, MSFC-PLAN-2785

1.5 Project Organization – The DCPCG project team consists of the primary contractor, the University of Alabama in Birmingham/Center for Biophysical Sciences and Engineering (UAB/CBSE), the Marshall Space Flight Center (MSFC) Project Manager, Systems Engineer, Safety and Mission Assurance office, Project Scientist, and engineering support from

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various Engineering Directorate, Flight Projects Directorate, and Science Directorate disciplines as deemed necessary. Refer to the DCPCG Project Plan for more details.

1.6 Project Description - The DCPCG hardware is described in the DCPCG Project Plan. DCPCG is a type II payload per MWI 7120.6. Due to the fact that this is a new practice being put in place for an existing project and since DCPCG has passed Science Concept Review (SCR), Requirements Definition Review (RDR), Authority To Proceed (ATP), Preliminary Design Review (PDR), and Critical Design Review (CDR); Failure Modes and Effects Analyses (FMEA's) and Fault Tree Analyses (FTA's) will not be performed.

1.7 Project Objectives -The DCPCG flight investigation objectives are listed in the DCPCG Project Plan.

2. APPLICABLE DOCUMENTS

The following documents of the latest issue (unless otherwise specified) form a part of this guide to the extent specified herein. In the event of a conflict between the documents specified herein and the contents of this guide, the contents of the DCPCG Project Plan shall be considered the superseding requirement. Quality Records will be maintained in accordance with SD40-OWI-003. The DCPCG Data Management Plan, DCPCG-PLAN-0002 contains a listing of the Quality Records associated with risk management.

DCPCG-PLAN-0002	DCPCG Data Management Plan
MSFC-PLAN-2785	DCPCG Project Plan
MSFC-PLAN-2889	DCPCG Quality Plan
MWI 7120.6	Program/Project Risk Management
NPG 7120.5A	NASA Program and Project Management Processes and Requirements
PCG-R-0003A	DCPCG Science Requirements Document
PCG-S-006	System Performance Specification for DCPCG
SD40-OWI-003	MSAD Quality Records Process

3. DEFINITIONS/ACRONYMS

ATP	Authority To Proceed
CBSE	Center for Biophysical Sciences and Engineering
CCB	Configuration Control Board
CDR	Critical Design Review
CRM	Continuous Risk Management
DCPCG	Dynamically Controlled Protein Crystal Growth
FMEA	Failure Modes and Effects Analysis
FRR	Flight Readiness Review
FTA	Fault Tree Analysis

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IRR	Integrated Readiness Review
MBPO	Microgravity Biotechnology Program Office
MSAD	Microgravity Science and Application Department
MSFC	Marshall Space Flight Center
MWI	Marshall Work Instruction
NASA	National Aeronautics and Space Administration
NPG	NASA Policy Guideline
PDR	Preliminary Design Review
PM	Project Manager
PR	Primary Reviewer
PWS	Performance Work Statement
RDR	Requirements Definition Review
ROM	Rough Order of Magnitude
SCR	Science Concept Review
SE	Systems Engineer
SRD	Science Requirements Document
UAB	University of Alabama in Birmingham

4.0 RISK MANAGEMENT APPROACH

4.1 Risk Management Philosophy – DCPCG is being developed under a modified performance-based contract. Consequently, UAB/CBSE (the contractor) is responsible for hardware specification, performance, and reliability internal to the project. UAB/CBSE is required by contract to provide risk management information to the DCPCG MSFC project team. Risks identified by UAB will be elevated and monitored by the government as appropriate. The project team will focus upon safety, carrier interfaces, quality, science and technical performance risks associated with satisfying the requirements stated in the Science Requirements Document (SRD) and the Performance Work Statement (PWS). Project resources will be applied as necessary to assure fulfillment of mission critical capabilities, and to minimize risk with respect to cost containment, achieving baseline performance objectives as identified in the DCPCG Project Plan, MSFC-PLAN-2785, and schedule maintenance, in that order.

4.2 Roles and Responsibilities - The MSFC DCPCG Project Manager (PM) is responsible for overall risk management on the DCPCG Project and the Systems Engineer (SE) is responsible for risk assessment and tracking, as stated in the DCPCG Project Plan.

The PM and the project team will prioritize and track open risks for the DCPCG project. Each risk will be assigned to a Primary Reviewer (PR), who will track the risk until it is dispositioned. The PR will provide risk status monthly during project team meetings. Through the risk assessment process, described in Section 5.1, risks will be given priorities of “High”, “Medium”, and “Low”, based upon their rankings in the Risk Matrix, reference Figure 3, part of the DCPCG Risk Management Database. Once the PR identifies the timeframe of a risk as imminently occurring, the PM will work with the PR and the team to develop mitigation and disposition action, including a schedule for accomplishing mitigation, a cost impact, and contingency plan if

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required. The project team and/or PR's will identify new risks or significant changes to existing risks monthly during team meetings.

The DCPCG project team members (including UAB/CBSE) are responsible for the following:

- a. Identifying risks, documenting the risks in the DCPCG Risk Management database, statusing risks, analyzing the identified risks, and supporting the project in developing mitigation options if necessary.
- b. Identifying and communicating how risks from their respective area might affect other program elements.

5.0 CONTINUOUS RISK MANAGEMENT OVERVIEW

DCPCG is implementing a continuous risk management process; this process will be iterated throughout the project life cycle. This section provides an overview of the Continuous Risk Management (CRM) process and its relation to the DCPCG Project Management, including primary activities, process steps, terms, and definitions. Details of the CRM process along with actions, tasks, and tools specific to the DCPCG Project, are provided in subsequent sections of this plan.

There are six primary activities of the CRM process:

- Risk Identification: continuous efforts to capture, acknowledge, and document risks as they are found. Risks are identified and defined on a Risk Information Sheet; an example is shown in Figure 1.
- Risk Analysis: an evaluation of all identified risks to estimate the probability of occurrence, severity of impact, timeframe of expected occurrence or when mitigation actions are needed, classification into sets of related risks if necessary, and priority ranking.
- Risk Planning: establishes actions, plans, and approaches for addressing risks and assigns responsibilities and schedules for completion. Metrics for determining the risk status are also defined during this step.
- Risk Tracking: an activity to capture, compile, and report risk attributes and metrics which determine whether or not risks are being mitigated effectively and risk mitigation plans are being performed correctly.
- Risk Controlling: an activity that utilizes the status and tracking information to make a decision about a risk or risk mitigation effort. A risk may be closed or watched, a mitigation action may be re-planned, or a contingency plan may be invoked. Decisions on the appropriate resources needed are also determined during this activity.

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<div>BACK TO HOMEPAGE</div> <div>PRINT THIS PAGE</div>		<h3>RISK INFORMATION SHEET</h3>		Identified <input type="text"/>
ID <input type="text"/>	Originator <input type="text"/>	Payload <input type="text"/>		
Priority <input type="text"/>	Statement <div style="border: 1px solid black; height: 60px;"></div>			
Probability <input type="text"/>				
Impact <input type="text"/>				
Rev. Change <input type="text"/>				
Time Frame <input type="text"/>	Origin <input type="text"/>	Class <input type="text"/>	Assigned to: <input type="text"/>	
Context <div style="border: 1px solid black; height: 80px;"></div>				
Mitigation strategy <div style="border: 1px solid black; height: 80px;"></div>				
Contingency plan and trigger <div style="border: 1px solid black; height: 80px;"></div>				
Status		Status Date <input type="text"/>		
<div style="border: 1px solid black; height: 60px;"></div>				
Approval <input type="text"/>	Closing date <input type="text"/>	Closing rationale <input type="text"/>		

Figure 1. Risk Information Sheet Example

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- Risk Communicating and Documenting: an overt action to communicate and document the risk at all steps of the CRM process. This can be in the form of an action item log, risk information sheet, risk database, mitigation plan, status report, tracking log, and/or meeting decision.

CRM is carried out during day-to-day activities of DCPCG Project personnel, as well as during key meetings. For DCPCG, only the "High" priority risks shall have any resources expended for mitigation. However, all other risks shall be watched or accepted. Watched risks shall have their attributes examined and reported on a monthly basis. Any risks that are identified but ignored are considered accepted. It is also understood that not all risks to a project are identified, and it is the intent of CRM to provide the means to handle identified risks.

5.1 Risk Management Process and Data Flow - Figure 2 illustrates the CRM process flow for the DCPCG project. The diagram depicts the functional relationships of the identification, planning, analyzing, tracking, and controlling activities and overlays the reporting and communication activities. This section provides a description of the detailed process steps.

5.1.1 Identifying Risks - The DCPCG project team shall identify risks by continually reviewing the safety, quality, science, and interfaces, as well as contractual baseline requirements, schedules, costs and all other relevant project elements. These items will be assessed against the project baseline to ensure that the technical, cost, and schedule objectives support compliance with project and Program requirements. This baseline set of risks shall be identified and entered as risk statements in the Risk Information Sheet, as shown in Figure 1. The DCPCG Risk Information Sheets are contained in Appendix A. Risk statements shall be written clearly and concisely, citing only one risk condition, and one or more consequences of that condition. All other relevant information shall be captured as Context describing the circumstances, contributing factors, and related issues. Each risk shall be identified by number (for configuration control) and shall have a PR assigned as owner. The PR's name shall be entered in the Risk Information Sheet.

All project personnel are responsible for identifying new risks. New risks identified during project related meetings shall be captured and added to the Risk Database within one week of the meeting. It is the responsibility of the meeting leader to make sure this is accomplished.

5.1.2 Analyzing Risks - Each risk will be evaluated using a 5-Level Attribute Evaluation method to determine impact, probability of occurrence, and timeframe, as shown in Figure 3 and contained in the Risk Information Sheets in Appendix A of this plan. Each risk shall be examined to determine its relationship to other risks identified. Initially, the identifier of the risk shall provide an estimate of these attributes. The SE, with assistance from the DCPCG team, shall be responsible for further analyses and prioritization of the risks. Historical data taken from past performance, experiences in other programs/projects, safety hazard analyses, continuous monitoring of interface and project level documentation, and utilizing personnel expertise in similar systems, are examples of techniques that will be used by the project to determine probability of occurrence estimates.

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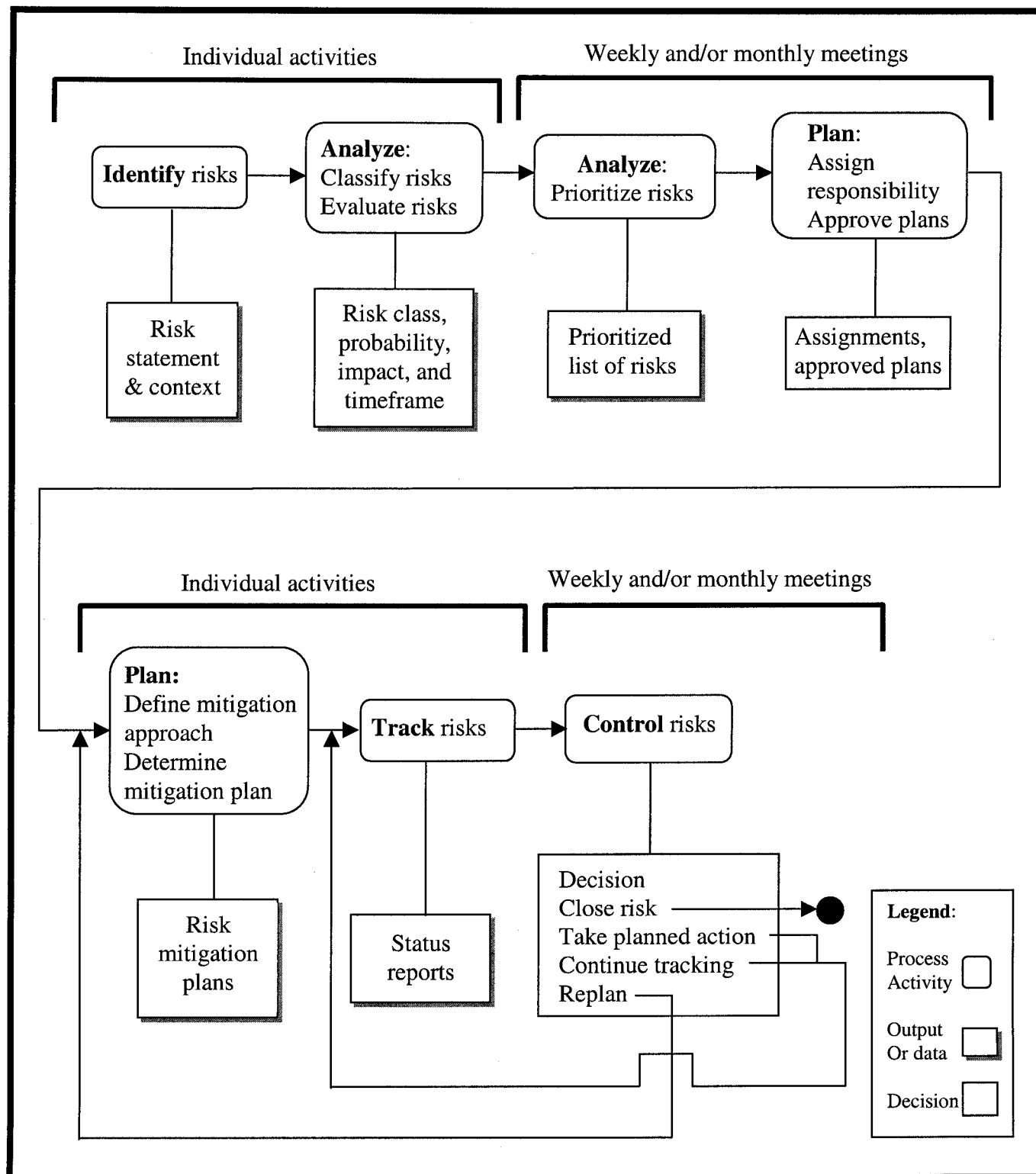


Figure 2. DCPCG Project Risk Management Process and Data Flow

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Risk Matrix

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H (High) - Implement new process or change baseline plan(s)

M (Medium) - Aggressively manage; consider alternative process

L (Low) - Monitor

What is the Probability the situation or circumstances will happen?

Level	DCPCG Team current process...
5	.. cannot prevent this event, no alternate approaches available
4	.. cannot prevent this event, but a different approach/process might
3	.. may prevent this event, but additional actions may be required
2	.. is usually sufficient to prevent this type of event
1	.. is sufficient to prevent this event

PROBABILITY

	L	M	H	H	H
	L	M	M	H	H
	L	M	M	M	H
	L	L	L	M	M
	L	L	L	L	M

1 2 3 4 5
 Impact

Given the event occurs, what is the magnitude (Impact level) of the impact to DCPCG Team?

Level	1	2	3	4	5
<u>Category</u>					
Technical	Minimal or no impact	Moderate performance reduction, same approach	Moderate performance reduction workarounds	Major performance reduction workarounds available	Unacceptable, no alternatives
Schedule	Minimal or no impact	Additional activities required. Able to meet Milestone	Key milestone slip < 1 month	Key milestone slip > 1 month Or Program Impacted	Cannot achieve key Team or major Program milestone
Cost	Minimal or No impact	Budget increase <5%	Budget increase >5%	Budget increase >10%	Budget increase >15%

Figure 3. DCPCG Risk Matrix

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5.1.3 Planning Risks - As newly identified risks are brought to a team lead or manager's attention through team meetings and database reports, they shall determine whether to keep the risk, delegate responsibility, or transfer the risk responsibility up the project organization chain. The PM, if necessary, may transfer a risk(s) to external organizations if that organization is best suited to handle the risk.

All "High" priority risks shall be assigned to a specific DCPCG team member for responsibility as the PR. This PR must answer for the status and mitigation of the risk. This person shall also assign risk mitigation actions to other DCPCG team members, as required.

Risk planning requires a decision to perform further research (creating a research plan), accept the risk (document acceptance rationale in the database and close the risk), watch the risk attributes and status (define tracking requirements, document in the database, and assign a "watch" action), or mitigate the risk (create a mitigation task plan, assign action items, and monitor the activities and risk). Note that only the "High" priority risks shall have any resources expended toward planning and mitigation.

Mitigation activities shall be by an action item list or through DCPCG mitigation task plans. Task plans shall be written for any effort that requires re-allocation of project resources. The PM shall determine when to use a mitigation plan.

5.1.4 Tracking Risks - Risk information and metrics defined during planning shall be captured, tracked and analyzed. The PR shall provide status reports on research and/or mitigation activities to the SE during the weekly DCPCG Project team meetings for his/her risks. Watched risks shall be reported on during the monthly DCPCG Project meetings.

5.1.5 Impacts to Cost and Schedule - Analysis will be performed to determine the impact of cost and schedule risks to the project. If cost or schedule impacts are expected to be significant, an analysis will be performed to determine how the expected schedule slip or cost overrun will affect the program. For significant cost risks, Rough Orders of Magnitude (ROM) estimates will be developed and for significant schedule risks, critical path analysis will be provided. The DCPCG PM will determine the budget source to mitigate risks that have cost impacts.

5.1.6 Impacts to Technical Performance - If the DCPCG system is brought to completion on time and within cost, but its performance fails to meet the science and carrier interface requirements, the system may still be considered acceptable for a specific flight. Non-conformance with the science and carrier interface requirements must be identified/addressed by UAB/CBSE through timely submittals of deviations/waivers as specified by the Contract. The DCPCG MSFC project team will immediately begin risk assessment as a result of this identification. No compromises to safety requirements will be entertained.

5.1.7 Mitigating Risk - Once a risk has been identified and the probability and consequences are assessed per the risk matrix contained in the database, the project will develop a

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mitigation strategy only for the “High” priority risks. The Microgravity Biotechnology Program Office (MBPO) has established the priority for the DCPCG project to be cost, performance, and schedule, in that order. Mitigation actions usually fall within the following areas:

- Schedule alterations: Develop work-arounds to remove the item from the critical path, apply more resources to the activity to reduce its expected duration, or assign schedule reserve, if feasible, to the item at risk.
- Cost management: Redirect money from other areas of the project or allocate reserve funds if possible.
- Technical performance: Investigate the availability of an off-the-shelf item, add tests to monitor progress, evaluate alternate sources, seek help from experts in related technical disciplines.
- Acceptance: Accept the risk as-is. Higher-level management approval is required to accept risks in the “high” and “medium” category.
- Descope: Evaluate descope options, impacts of descope, and benefits of descope.

Each individual risk item will lend itself to specific mitigation activities. It is the responsibility of the DCPCG team members to generate viable mitigation actions, if mitigation is the path chosen to follow. Sections 5.1.7.1 through 5.1.7.3 describe the phases of the risk mitigation process.

5.1.7.1 Identify Mitigation Options - The DCPCG team members will support the PR in developing specific mitigation options for individual risk items. Only the “High” priority risks will be required to have mitigation plans. The PM will approve the mitigation actions to be taken. It is important that all areas of program risk (cost, technical, and schedule) be considered in the generation of mitigation options. The project team will analyze and assess each option, and will perform an initial “screening” to remove any options that are not feasible from consideration.

5.1.7.2 Assess Mitigation Options - Each mitigation option will be analyzed to ensure that other risks are not induced or worsened by the solution. Following this assessment, the most effective course of action will be chosen. Each option must be reviewed to address both internal and program-wide impacts. Impacts to the following areas must be identified:

- Costs: Non-recurring and life cycle costs.
- Technical: System performance, operations, and carrier interfaces.
- Schedule: The amount of time the mitigation plan will take to implement the impact on the critical paths, and a determination if sufficient resources exist to support the plan.

From the mitigation options identified, the appropriate mitigation strategy will be selected by the PM and SE, based on recommendations by the other team members.

5.1.7.3 Implementation Strategy - Once a mitigation option has been chosen, the project will develop a mitigation plan. The DCPCG Risk Information Sheet (Figure 1) will be utilized for the collection of the required risk information. The mitigation plan will be an attachment to the

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Risk Information Sheet and will identify steps required to close the risk item. Figure 4 shows an example of the format for the Mitigation Plan, which will be contained in the DCPCG Risk Management Plan Appendix B. The plan will have the following characteristics as a minimum:

- a) Each plan shall define a set of tasks/actions with a defined schedule. A DCPCG team member will be identified as the focal point for each action.
- b) Identified risks and mitigation plans will be statused at team meetings and presented at management reviews.
- c) The plan will contain a "fail safe" point. This will be a point in the plan where a "fallback" method or recovery plan will be enacted if the risk has not been reduced to a defined threshold.
- d) The plan will contain an end point including closure criteria. An end point is a point in the program that can be defined (e.g., when a hardware item is qualified or drawings are back on schedule).

The PM will coordinate activities necessary to assure the accomplishment of the mitigating action. These activities include officially notifying UAB/CBSE, initiating procurement actions, assigning and tracking actions within MSFC or other NASA centers. Risks may be identified which fall outside the immediate scope of the DCPCG project, or which are sufficiently significant to require higher-level management attention and direction, for example, when risk mitigation requires additional funding outside the DCPCG project control and/or budget. When such a risk is identified, higher-level management will be notified, and options for mitigation presented.

5.1.8 Controlling Risks - Decisions shall be made by the PM during the weekly and monthly team meetings to close risks, continue to research, mitigate or watch risks, re-plan or re-focus actions or activities, or invoke contingency plans. This is also the time when the PM authorizes and allocates resources toward risks.

5.1.9 Communicating and Documenting Risks - Weekly project meetings shall encourage the identification of risks. Monthly project meetings shall include status of risks and decisions for controlling risks and risk management activities. The baseline set of risks shall be reviewed and re-established on a project milestone basis. All risk information shall be documented in the Risk Management Plan and is accessible by all DCPCG project personnel. Only the PR for the risk shall have the authority to update the risk information.

6.0 DCPCG RISK REPORTING

This section describes how the risk information will be documented, retained, controlled and utilized. Maps of the risk management activities against the project milestones shall be developed. This includes established baselines, major reviews of risk status, and routing activities. The following milestones shall be used:

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<div>Risk ID:</div> <div></div>		<div>Risk</div> <div></div>	
		<div>Date:</div> <div></div>	
<div>Approach:</div> <div></div>	<div>Watch:</div> <div></div>	<div>Accept:</div> <div></div>	<div>Mitigate</div> <div></div>
<div>Risk</div> <div>Priority</div> <div>Probability</div> <div>Impact</div> <div>Timeframe:</div>	<div></div> <div></div> <div></div> <div></div>	<div>Fail Safe Point</div> <div></div>	<div>End Point</div> <div></div>
<div>Root Cause Descriptions</div> <div></div>			
<div>Mitigation strategy</div> <div></div>			
<div>Actions</div> <div>1.</div> <div></div> <div>2.</div> <div></div> <div>3.</div> <div></div> <div>4.</div> <div></div> <div>5.</div> <div></div> <div>6.</div> <div></div> <div>7.</div> <div></div> <div>8.</div> <div></div> <div>9.</div> <div></div> <div>10.</div> <div></div>	<div>Fiscal Year</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div>	<div>Start Date</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div>	<div>End Date</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div>
		<div>Estimated</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div>	
		<div>Total Estimated Cost</div> <div></div>	

Figure 4. Risk Mitigation Plan Example

CHECK THE MASTER LIST VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE

DCPCG SD45		
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- Monthly project meetings shall include risk status including decisions for controlling risk and risk management activities
- The status of the “High” priority risks shall be summarized and reported to the DCPCG PM on a monthly basis.
- The baseline set of risks shall be reviewed and re-established at significant project milestones (e.g., PDR, CDR, Integrated Readiness Review (IRR), and Flight Readiness Review (FRR)).

The PR will be responsible for updating the risk information. The updating of risk information shall be performed using the Risk Database. The designated team member shall also be responsible for documenting the lessons learned before closing the risk.

7.0 RISK MANAGEMENT DOCUMENTATION AND ARCHIVING

All DCPCG risk management products and action items will be documented in the DCPCG Risk Management Plan Appendix A, Risk Management Database. This database includes a Risk Spreadsheet listing of identified risks, Risk Information Sheets and any resulting risk action items. Also included in the database are all associated Mitigation Plans, which will be documented in Appendix B. The SE will track, document, and analyze the DCPCG risk management data as defined in this plan and/or as directed by the PM.

8.0 APPENDICES

- Appendix A DCPCG Risk Management Database - See DCPCG Systems Engineer for latest copy of Risk Management Database.
- Appendix B DCPCG Mitigation Plans - See DCPCG Systems Engineer for latest copy of Mitigation Plans.

9.0 RECORDS

All DCPCG risk management quality records will be maintained per the DCPCG Data Management Plan, DCPCG-PLAN-0002.